the atomic weight, 1·31. Very simple elements can exist therefore in which the atomic number differs from the number of electrons, and Dr. van den Broek's hypothesis cannot be a complete principle, although perhaps satisfactory for the stable terrestrial elements. Nevertheless, if it is satisfactory in this range, Bohr's theory is not. J. W. NICHOLSON.

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Temperature-Difference between the Up and Down Traces of Sounding-Balloon Diagrams.

IN his paper on the daily temperature change at great heights (January issue of the Quart. Journal of the Roy. Met. Soc.), Mr. Dines deals with the double traces shown by the diagrams of registering-balloons. He ascribes the difference for a great deal to the heating effect of the balloons, as the instruments swim in the wake of dead but heated air that follows the ascending balloon.

He rejects as a possible cause any thermal lagging of the instrument, because the double trace is most apparent in the isothermal layer, and also because it mostly occurs by day and not by night.

Receiving this number of the Quart. Journal, it just happened that I had made a synopsis of this kind of temperature-difference for the Batavian ascents, which throws another light on this question.

At Batavia the balloons are of a larger type than those used in England; also the string between balloon and instrument is much longer, measuring 30 m. and more. Moreover, it has been observed in numerous cases that up to the greatest heights the whole system of balloon-parachute-instrument often swings strongly. Accordingly any heating effect by the air in the wake of the balloon seems most improbable.

The instruments are of the pattern usual on the continent and made by Bosch (Strassburg); they are provided with clockwork. When possible the heights have been calculated separately for the ascent and the descent; thus, when the downward temperatures were found to be lower than the upward, the corresponding heights became lower, and accordingly the difference of temperature for the same calculated height in the ascent and the descent was increased. In half of the thirty ascents which up to the present have been made, the balloon was liberated 1–1½ hours before, and in the other half 1–1½ hours after sunrise. Thus, in the first cases only the latter part of the descent took place at an hour that solar radiation begins to be active.

The mean differences found are:—

Temperature Higher in the Ascent than in the Descent.

Height in km.	Before sunrise °C.	After sunrise °C.	Number of cases	
			Before	After
1	0·0	0·4	16	14
2	0·1	0·4	18	14
3	0·4	0·9	18	16
4	0·2	1·4	18	16
5	0·2	1·5	17	15
6	0·7	2·4	16	15
7	1·0	3·0	17	12
8	1·2	3·3	15	13
9	1·3	3·2	15	12
10	2·2	4·4	15	11
11	2·7	4·6	15	11
12	3·0	4·3	15	11
13	3·4	5·0	15	10
14	3·8	3·6	13	9
15	3·3	2·9	12	9
16	3·5	2·5	6	5

The prominent fact, demonstrated by this table, is that up to 13 km. the differences before sunrise are much smaller than those after sunrise.

The synopsis teaches, that before sunrise negative values occur in all heights, especially below 7 km. In one case up to the stratosphere the difference was negative in all heights.

On the contrary, in another ascent it went up to 9·2°. After sunrise no ascent, with negative values only, occurred, and in one case the differences amounted to 11·2°.

For the stratosphere, only in eight cases a set of these differences was obtained, its height being so great in these low latitudes that only part of the balloons reach its layers. Only in one of these cases (after sunrise) the descent-temperatures in the stratosphere exceeded those of the ascent, and in another case (before sunrise) higher temperatures alternated with lower.

In the five other cases (before sunrise) the sign of the differences in and below the stratosphere were contrary. It must be borne in mind that scarcely any isothermal state prevails in the tropical stratosphere, but that the temperature increases with the height (*cf.* my letter in NATURE of March 5, p. 5).

However, in the above-mentioned case of alternating positive and negative values, isothermal condition was met with up to 23 km.

The reversal in sign of the difference, which accompanies the reversal of the temperature gradient, strongly points to a thermal lagging of the instrument. Its heavy parts, and the basket also, will lag strongly and will influence the thermograph. In the ascent the lesser the ventilation the greater the heating. Thus the influence will increase with the height, as the ventilation decreases. In the descent the ventilation in most cases was greater than in the ascent, and accordingly the negative lagging less. After sunrise the thermal lagging of the basket will be enhanced in the ascent by sun-radiation, which easily explains the fact that the differences are larger after than before sunrise.

Perhaps the English instruments, being smaller than the German, have a smaller thermal lag than the latter. Thus Mr. Dines's explanation may be applicable to the facts observed in England, and mine to those met with in Java. From them I think the following lessons may be learnt, which applies to most Continental ascents made in a similar way and with the same pattern of instruments:—

(1) The temperatures of ascent and descent should be averaged.

(2) When descent or ascent is available only, a mean correction, to be derived from a large number of corresponding cases, should be applied.

(3) The temperatures and heights taken from the publication of the International Committee, in which, in most of the cases, ascents only are given, are affected by a systematic error.

W. VAN BEMMELEN.

Batavia, March, 1914.

Cellular Structure of Emulsions.

THE same arrangement that is shown by Fig. 2, in NATURE of May 7 (p. 240), may be seen in an emulsion of Oriental finely powdered coffee suspended in milk and water. I have supposed that it is connected with a strange phenomenon which I reported in NATURE about forty years ago. Sooty rain-water, after standing for some hours, will develop clear planes of water, as much as 10 cm. long and only 1 or 2 mm. wide. These planes are most readily seen by candle light when vertical, but may develop at any inclina-

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tion, and change inclination. Such a straight segregation of clean water shows that no self-attraction of the suspended solids can be the cause. In a recent point of view it looks like a liquid crystal arrangement of water expelling the powder as foreign matter, especially when we remember the habit of ice crystals in very thin plates. The question then arises, Are all these emulsion figures due to the clear liquid segregating and expelling the suspended matter?

W. M. FLINDERS PETRIE.

MODERN FORMS OF RONTGEN-RAY TUBES.

IN spite of many obstacles, medical technique in the application of Röntgen rays has made steady progress during recent years. But there still remain certain primary difficulties which are often a source of hindrance and confusion. The demand for a more trustworthy method of working than exists to-day is the natural outcome of wider radio-therapeutic experience, but what is required above all is an accurate means of measuring the output of the tube.

The solution of this problem clearly requires that we shall have at our disposal an apparatus capable of emitting a specific type of ray in definite quantity; and were it not for some experiments by Dr. Lilienfeld, and more recently by Mr. Coolidge, of New York, there would be little prospect of actually realising this result in practice. I shall refer to their work more in detail later.

Meanwhile, it is worth noticing that the modern X-ray tube, with all its imperfections, is a triumph of craftsmanship. It is the result of numberless costly and difficult experiments carried out by manufacturers and others to meet a demand which grows more exacting every year. The collection of historical X-ray tubes brought together some time ago by the Röntgen Society, and now on view in the Science Museum at South Kensington, contains the first bulb which embodied the chief features adopted universally up to the present time in the construction of X-ray tubes. That bulb was made by Prof. Herbert Jackson in 1896, and measures only 3 in. across. The diameter of those in use to-day is, however, usually twice or three times as great, the electrodes being heavy and the vacuum carefully adjusted.

The successful working of the apparatus depends so largely upon this last factor that decrease in pressure of the residual gas, invariably accompanying prolonged use, has to be compensated for. The devices employed for regulating the vacuum may be divided into three main classes, viz., those:—

(1) In which a few discs of mica, a piece of carbon or asbestos, etc., fixed within the bulb, offer an alternative path for the discharge, so that gas is, when necessary, liberated by the heat generated, as the electric current follows the line of least resistance.

(2) In which a fine palladium tube stopped up at one end has a small tubular extension of platinum soldered to it for sealing into the X-ray bulb. A gas flame brought near so as to heat the palladium enables hydrogen to enter by osmosis, and so lower the vacuum. All the tubes used in the X-ray treatment cubicles at the London Hospital, for instance, have these "Osmo" regulators.

(3) In which air is allowed to enter through the pores of a piece of unglazed porcelain, which is usually sealed with mercury until by a pneumatic contrivance it is momentarily uncovered.

But none of these methods is free from objections. The regulation is generally too insensitive. The tube often outlives the supply of gas from the first sort, and the others are only trustworthy in skilled hands. The mica disc regulator is shown in the diagram (Fig. 1), which otherwise is self-explanatory.

Messrs. C. H. F. Muller describe some eighteen types of tubes of this character in their recently published catalogue, and give precise instructions for the adjustment and use of each kind. There are in addition five coloured plates showing the appearance of X-ray bulbs in action, and a great amount of useful information besides. Fig. 2 (Muller) may be taken as representing a typical example of modern heavy discharge X-ray tube.

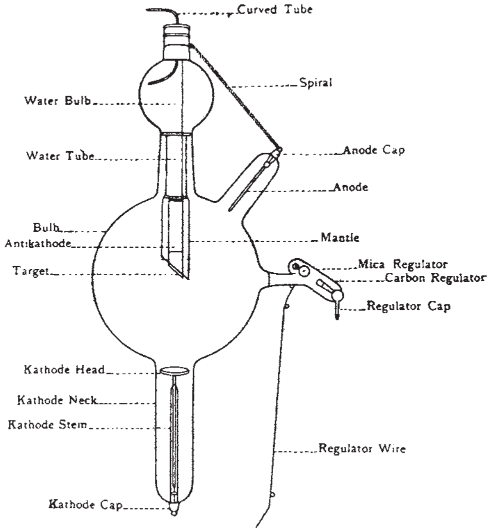

FIG. 1.—Showing the terms in common use to denote the different parts of the instrument.

The cause of the disappearance of gas with prolonged use has given rise to much speculation. It has been suggested that the ions produced by the discharge are driven actually through the walls, and so escape; there is proof at least that the glass takes up a large part of the residual gas under these conditions, and that lead glass absorbs more than Jena.

Since the degree of vacuum controls the resistance of the tube, and this in turn determines the current that passes with a given potential difference between the electrodes, it is evident that the pressure of the residual gas is the chief factor which defines the type and quantity of rays to be

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